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(54) IMPROVEMENTS IN AND RELATING TO FLEXIBLE CONDUIT

(71) We, ATCO RUBBER PRODUCTS, INC., a corporation organised and existing under the Laws of the State of Michigan, United States of America, of 12461-172nd Street, Grand Haven, Michigan, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to flexible conduit and to methods of forming flexible conduit.

A substantial amount of technology exists on the machinery and techniques for manufacturing flexible conduit. Flexible conduit is presently manufactured in substantial quantities, chiefly for gaseous flow usage, e.g., ventilating systems, automotive uses, suction cleaning apparatus and the like.

Typically, conduit is formed by embedding a reinforcing strand such as wire between two layers of material. These layers are sometimes formed of certain polymers which can be softened sufficiently under heat treatment in ovens to fuse together. The particular polymers suitable for this are quite specific and known, as are the times and temperatures required for this fusion operation. Alternatively, strip material is constantly coated with adhesive in a volatile carrier, wound before the carrier evaporates, and then heat cured to drive off the volatile carrier from between the layers.

Unfortunately, as is well known, both alternatives require substantial heating time. Also, the human operators of the equipment are exposed to potential toxicity and explosions, particularly when driving off volatile adhesive carriers, if conditions do not remain under complete control. Legal considerations and common decency therefore necessitate installation and use of special ventilating and air control equipment, in addition to the large ovens and conduit handling equipment. Needless to say, the expense is very substantial.

Further, the materials adaptable to present forming techniques generally have unsatisfactory flame and smoke ratings.

According to one aspect of the present invention, a method of forming flexible conduit comprises: providing a tubular liner, helically winding a reinforcing strand around the exterior of the tubular liner, and helically wrapping around the reinforcing strand and liner, into engagement with the liner and the strand fully to cover the liner and the strand and into overlapping relationship on itself, a layer of tape, at least one of (a) the outer face of the tubular liner and (b) the inner face of the layer of tape being a pressure sensitive adhesive face.

The tubular liner may be produced in various ways. For example, it may be formed of a sheet material. Alternatively, it may be produced by helically winding, in overlapping relationship on itself, a second layer of tape.

According to another aspect of the invention, a flexible conduit comprises an inner cylindrical liner, a helically arranged strand with spaced turns in engagement around the outer periphery of the liner, and an outer generally cylindrical wrapping composed of a helically arranged and overlapping tape, at least one of (a) the outer face of the liner and (b) the inner face of the wrapping tape being a pressure-sensitive adhesive face.

The invention may be carried into practice in various ways and two flexible conduits and their method of forming in accordance with the invention will now be described by way of example with reference to the accompanying drawings, in which: —

Figure 1 is a fragmentary elevation of a portion of flexible conduit;

Figure 2 is a substantially enlarged fragmentary sectional view of a portion of the flexible conduit shown in Figure 1; and

Figure 3 is another substantially enlarged fragmentary sectional view of a second flexible conduit.

The flexible conduit 10 shown in Figures 1 and 2 has a generally cylindrical configuration. It is composed of an inner liner, a reinforcing strand, and an outer wrapping.

The reinforcing strand 12 is formed by a single metal wire which is arranged helically along the construction. The inner liner 14 is of unitary sheet stock formed into a generally cylindrical configuration initially from polymer film material. After forming the inner liner, the reinforcing strand 12 is helically wound in spaced fashion therearound as depicted. This is done by using a mandrel of the type shown in copending British Patent Application No. 51290/73 (Serial No. 1 451 469). Then the outer wrapping 16 of the flexible conduit is formed from a strip of polymeric tape having pressure-sensitive adhesive only on one face thereof. Such pressure-sensitive adhesives are commonly known and available. Selection of a particular one is significant only if a particular usage requires it. This tape is wound helically around the inner liner 14 and reinforcing strand 12, while adjacent layers 16*a* and 16*b* are overlapping as at 17. This adhesive tape thereby embodies the turns of reinforcing strand 12. It adheres tightly to the outer face of the liner 14 and the surfaces of the reinforcing strand to lock the components into an integrated yet flexible assembly. The pressure which the wrapping causes between the overlapping surfaces is adequate to unify the assembly. It is possible, but normally not necessary, to apply subsequent heat and/or further pressure for even further bonding of the components. The resulting conduit is basically cylindrical in configuration. If another cross sectional configuration is desired, the conduit can be reformed by conventional post-forming techniques to obtain e.g. a polygonal, oval, or other cross section.

In the second embodiment depicted in Figure 3, instead of the generally unitary film or sheet of material forming the inner liner 14, a modified inner liner 14′ is formed by the use of tape. In this instance, when tape is used for both the inner lining and outer wrapping both have pressure-sensitive adhesive on one face since this assists in bonding overlapping turns of the tape to each other. The inner tape is helically wound with the adhesive face oriented outwardly in a fashion to overlap and bond to itself in successive turns, and also for bonding to the reinforcing strand and the outer wrapping. The reinforcing strand material 12 is helically wound with its successive turns in spaced relationship thereon, to adhere to the inner liner and retain its position until the outer wrapping 16, with its pressure-sensitive face radially inwardly is wound into place, in fashion similar to that explained relative to the embodiment in Figure 2. The adhesive outer wrapping is securely adhered to the inner liner, the pressure-sensitive coatings engaging each other and firmly embedding the reinforcing strand. The outer wrapping completely envelopes any sticky surface area between it and the inner lining.

Although the outer wrapping 16 and the inner liner 14 and inner wrapping 14′ are described above as being of polymeric materials the choices of materials is very wide. Various polymeric materials, laminates of polymers and metal foil and/or paper, laminates of cloth and polymer, cloth alone, fibreglass reinforced polymers and foam polymer ribbon stock, are exemplary.

Using tape in the fashion described, it has been found that extremely high speeds of formation can be employed. No adhesive setting or drying time is necessary, and no ovens. No explosion hazards or toxicity problems are presented to persons operating the equipment. There is no volatile adhesive carrier. Moreover, the selection of material useful for the flexible conduit is almost unlimited. Hence, materials can be selected which enable the resulting conduit to be employed for heating conduits and the like. This factor, of course, provides tremendous flexibility to architects, contractors, and others involved with construction of buildings, mobile homes, and other equipment where flexible conduit could be handily employed.

Although the strands 12 described above are of metal, other materials such as polymers may be used if they are capable of being helically arranged and have flexibility to allow the resultant hose or conduit to be flexible. Also, although the conduits described above each has a single strand 12, a conduit may be made having more than one strand arranged like a multi-start screw.

Although, in the two examples shown, in one case the inner face of the outer tape has pressure-sensitive adhesive and in the other both the outer face of the tubular liner and the inner face of the tape have pressure-sensitive adhesive, an arrangement is possible in which only the outer face of the tubular liner has pressure-sensitive adhesive.

Testing procedures have shown that the construction can be fabricated extremely rapidly, with the resulting product being suitable for a variety of uses.

Once the concept set forth herein is understood, it seems very simple. Indeed, the very simplicity of this invention is one of its greatest attributes, since the resulting product has qualities equal to those of present conduit in some areas, qualities superior to present conduit in other areas, and yet is capable of formation without expensive and complex heat treating and ventilation equipment normally required, and without exposing workers to hazardous conditions.

WHAT WE CLAIM IS:—

1. A method of forming flexible conduit comprising: providing a tubular liner, helically winding a reinforcing strand around the exterior of the tubular liner, and helically wrapping around the reinforcing strand and liner, into engagement with the liner and the strand fully to cover the liner and the strand and into overlapping relationship on itself, a layer of tape, at least one of (a) the outer face of the tubular liner and (b) the inner face of the layer of tape being a pressure sensitive adhesive face.

2. A method as claimed in Claim 1 in which the tubular liner is produced by helically winding, in overlapping relationship on itself, a second layer of tape.

3. A method as claimed in Claim 2 in which the tape of the second layer has a pressure-sensitive adhesive outer face.

4. A method as claimed in Claim 3 in which the tape of the layer wrapped around the liner has a pressure-sensitive adhesive inner face.

5. A method as claimed in Claim 1 in which the tubular liner is formed of a sheet of material.

6. A method of forming flexible conduit substantially as described herein with reference to Figures 1 and 2 or to Figure 3 of the accompanying drawing.

7. A flexible conduit when produced by a method as claimed in any of the preceding claims.

8. A flexible conduit comprising: an inner cylindrical liner, a helically arranged strand with spaced turns in engagement around the outer periphery of the liner, and an outer generally cylindrical wrapping composed of a helically arranged and overlapping tape, at least one of (a) the outer face of the liner and (b) the inner face of the wrapping tape being a pressure-sensitive adhesive face.

9. A flexible conduit as claimed in Claim 8 in which the inner cylindrical liner is composed of a helically arranged and overlapping tape.

10. A flexible conduit as claimed in Claim 9 in which the outer face of the inner tape and the inner face of the outer tape are both pressure-sensitive adhesive faces.

11. A flexible conduit substantially as described herein with reference to Figures 1 and 2 or Figure 3 of the accompanying drawings.

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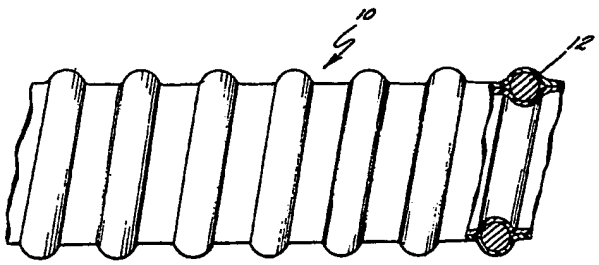

FIG. 1.

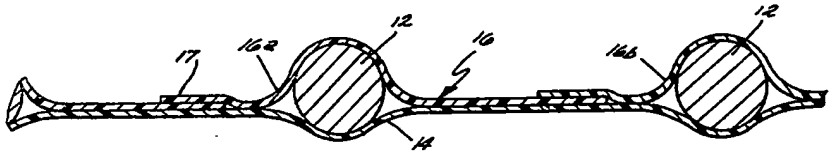

FIG. 2.

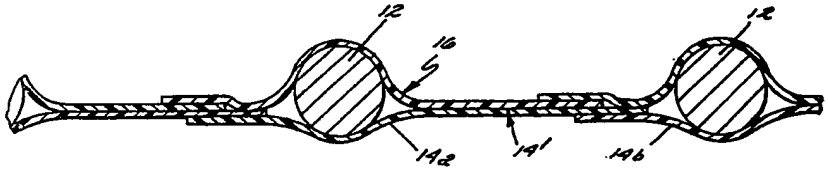

FIG. 3.